

When to Call an Engineer

by Glenn Mathewson

One clear way to know that you need professional help with your deck design is when the building department asks for stamped drawings from a licensed professional. (Who that is varies from state to state. Some states, like California, require a structural engineer, and others, like Colorado, allow the stamp of a licensed architect.) However, in my experience, that doesn't happen often enough; during plan submittal, building departments are more

likely to ask too few questions, with the result that many insufficiencies get discovered — or worse, ignored or overlooked — at the final inspection.

So, if your building department doesn't offer adequate guidance, how are you to know whether you should seek assistance from an engineer? You could look at the 2009 International Residential Code, but often the IRC is complicated and ultimately insufficient. You might also see if your local building department will accept the

American Wood Council's *Prescriptive Residential Wood Deck Construction Guide, DCA-6* (awc.org/publications/dca/dca6/dca6-09.pdf) as an alternative to the IRC. If these publications don't answer your concerns, read on. Though I can't give you a definitive answer, I can offer a little advice.

Ledgers

All the forces applied to a structure ultimately end at the earth, and a load path is how they get there. You stand on the decking, it's supported by the joists, by the beam, by the posts, by the footings — this is a load path, and it's different for each and every point on the deck.

When it comes to ledgers, understanding the construction of the existing building (the house) is as important as understanding the new deck. This is because the house supports the ledger, making the existing structure a critical part of the continuous load path for the deck. This is also where the load path often becomes less obvious.

The complexity of the load paths in an existing building can affect the portions of the deck supported by the ledger. Is the floor cantilevered? Is there an opening in the wall below the floor where the new deck attaches? Will the ledger attach to a solid or engineered rim joist, studs, CMU, or concrete? For almost all decks, these questions should be answered before beginning design. If you can't answer them yourself, you need an engineer.

The question of how to properly reach the existing structural components must also be answered, as

Beam Size Depends on Tributary Area

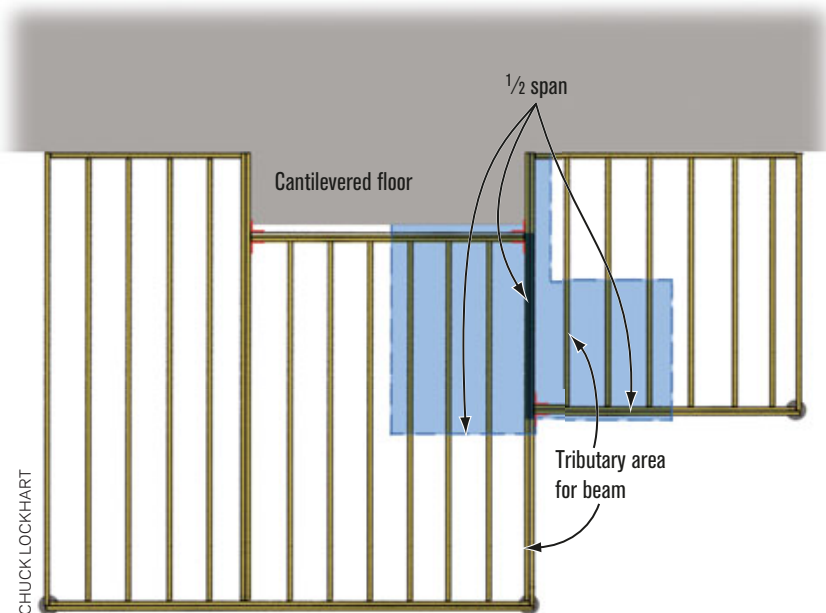


Figure 1. Calculating the tributary area for a point on the deck is not difficult. On your structural layout, draw dashed lines that halve the joist and beam spans. Follow the supporting path for each area back to the component in question and multiply by the pounds per square foot designed for — usually 50 pounds per square foot of live and dead load. In this example, notice the area of deck supported by the middle span of one beam. Depending on the size of the tributary area, this beam may need extra consideration.

you have to get past the exterior cladding first. This requires understanding various types of claddings and veneers, such as anchored or adhered masonry, wood/vinyl/metal siding, stucco, or EIFS. And while these may not directly be structural engineering concerns, they certainly require a professional analysis and approach to ensure a proper execution, as water intrusion to critical locations can make a good structural system fail.

Concentrated Loads

For many decks, even multilevel ones, the framing is simple. Posts support beams, which support uniformly-distributed joists, which support uniformly-distributed decking, which supports a generally uniform distribution of people and their stuff. The key to the simplicity of this framing is in the phrase “uniformly distributed.” Place a hot tub on the deck and the uniformity is lost, and typically an engineer is needed. (For ground-

level decks, you’re better off placing the hot tub on a concrete slab and framing the deck around it.)

Decks that aren’t simple rectangles often have concentrated loads within the framing system. A ground-level deck can be supported by a bunch of posts on each end, making the framing simple. With upper-level decks however, a forest of posts may not be acceptable, which leads to complex framing where beams support other beams. Many decks like this are built without any real consideration of the load path through those beams, other than just doubling every member that carries another. But to ensure the structure is safe, the load path should be examined and the tributary load for each beam end and post should be determined (**Figure 1, previous page**). This is important for sizing not only members, but hangers and foundations as well.

Section R502.10 of the 2009 IRC provides some guidance and

limitations in regard to beams supporting beams. Provided the spans for the selected joist size are within the limitations of the span tables in the IRC, a single member can act as a beam (header joist) up to a maximum 4-foot span. This can work well for a small stair landing or framing around a narrow brick chimney. You also must consider at what place in the span the first beam (header) connects to the second beam (trimmer). If a 4-foot or shorter header is connected within 3 feet of the trimmer’s bearing location, the trimmer can also be a single member (**Figure 2**).

Beyond those limits, the IRC requires both beams — header and trimmer — to be doubled and “of sufficient cross section to support the floor joists framing into the header.” Without an analysis of the loading, you can’t know what size beam is necessary to support the floor joists. The more complicated the deck, the more complex the load path, and the more crucial it becomes that a calculative analysis be performed.

Even loads that are placed directly over posts, as opposed to mid-span of beams, can have negative results. “Bearing area” is the area of a member in contact with another member at the point of load transfer. The amount of load that can be transferred is limited by the amount of bearing area and the properties of the material. Forces transferred through wood in a direction parallel to the grain (such as when a beam rests on a post) can damage and crush the wood fibers. This not only shifts the joint (lowers the beam), but can lead to more rapid decay and structural failure.

The IRC requires a joist or beam to bear a minimum of 1.5 inches on its supporting member, based on the expectation that the design will not exceed the other limitations in the

Not All Headers and Trimmers Need Doubling

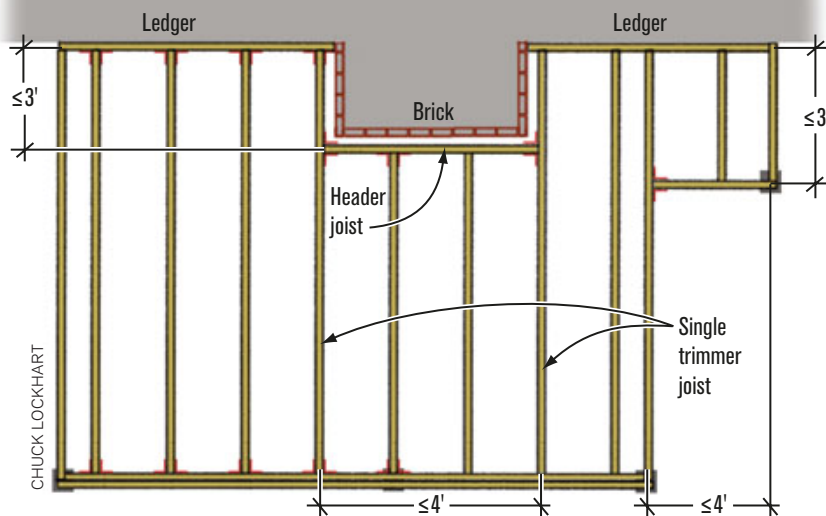


Figure 2. For framing around chimneys or floor cantilevers and for framing a stair landing, the IRC has some clear allowances. When using single trimmers, the maximum span between them is 4 feet, and the header must be within 3 feet of the trimmers’ bearing points. Doubling the header or trimmer members can get you greater spans.

STRUCTURE

code, such as uniformly distributed loads and maximum spans. Once the load path becomes complicated and members are not uniformly loaded, loads greater than those anticipated in the code can result and cause failure at the bearing location.

No Guesswork

There are other issues that deck builders should consult an engineer about. Lateral resistance, for exam-

ple, should get the attention of an engineer far more often than it does. Decide when to get the assistance of an engineer based on the complexity of the work you do. What I don't recommend is relying on your local building department to tell you.

Regardless of the deck being built, an analysis of the load path should be performed. If it's a simple deck, no problem: Use the IRC and conventional framing. For a complicated

deck, make sure someone competent verifies that the structural system works. The guesswork that has been notoriously accepted for deck structural design in years past is proved insufficient with every deck that collapses. ❖

Glenn Mathewson is a project manager for Bornengineering in Westminster, Colo., and a former deck builder and building inspector.